

Climate and colonialism

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Abstract

Recent years have seen a growth in scholarship on the intertwined histories of climate, science and European imperialism. Scholarship has focused both on how the material realities of climate shaped colonial enterprises, and on how ideas about climate informed imperial ideologies. Historians have shown how European expansion was justified by its protagonists with theories of racial superiority, which were often closely tied to ideas of climatic determinism. Meanwhile, the colonial spaces established by European powers offered novel ‘laboratories’ where ideas about acclimatisation and climatic improvement could be tested on the ground. While historical scholarship has focused on how powerful ideas of climate informed imperial projects, emerging scholarship in environmental history, history of science and historical geography focuses instead on the material and cognitive practices by which the climates of colonial spaces were made known and dealt with in fields such as forestry, agriculture and human health. These heretofore rather disparate areas of historical research carry great contemporary relevance of studies of how climates and their changes have been understood, debated and adapted to in the past.

Introduction

In its capacity to colonise the deepest recesses of the human mind, climate must surely constitute one of the world's most successful imperial projects (Livingstone, 2015: 937)

Contemporary narratives of climate change concern the anticipation of temporal change in the mean values and possible extremes of global climate. At a regional or local level, these visions of global, temporal change are often translated into spatial analogues – for example, arguments are made that the climate of Great Britain is set to transform at some future point into something like that of the present-day Mediterranean. Spatial analogues have proven popular techniques for constructing and communicating scenarios of future climate change, both within science and in wider cultural discourses (e.g. Jylhä et al., 2010). This cultural concern with the migration of ‘regional’ climates also has a historical analogue, in the history of European encounters with foreign climates during the period of European colonial expansion. Here, it wasn't climates which were on the move (although debates about climate change were prominent in colonial settings – see below), but people – most notably soldiers, sailors, missionaries, administrators, settler farmers and labourers in various forms of bondage. Significant debates ensued about human adaptation to new climates, about understanding, predicting and perhaps

taming climatic variability, and about the relationships between climate and new, trans-global forms of economic production and exchange.

A number of authors have recently surveyed the value to be gained for contemporary studies of climate change, and societal responses to climate variability, from reconstructions of past climates, where information is gleaned from colonial records, diaries, ship logs, missionary records, and so on (Adamson & Nash, 2013; Allan et al., 2016; Carey, 2012). Others have begun to study the influence of climatic factors on colonial life and politics, such as hypothesized links between climate and violence (Papaioannou, 2016). However, along with these material reconstructions of climate variability and its impacts, it is vital to bear in mind historical changes in conceptualisations of climate itself, and their impacts on the conduct of colonialism (Locher and Fressoz, 2013).

A growing strand of historical scholarship is examining intersections between climate and empire: the ways in which ideas about climatic difference and superiority informed racist imperial ideologies; the everyday practices by which settlers and administrators sought to understand and deal with the new climates in which they dwelled; and efforts to develop more formal, scientific knowledges of colonial atmospheres. This article reviews this expanding field of scholarship, focusing on work which examines how colonists made knowledge about weather and climate and put it to use in the administration and inhabitation of colonial spaces. In the following section, we briefly review established historical work on the ideological aspects of climate and empire before looking more closely in the subsequent sections at emerging work on climate and the practices of colonialism.

As a set of ideas and images about fundamental differences between the Western 'Self' and its alien 'Other' (Said, 1979), imperialism was (and is) made manifest in a variety of different forms of colonialism – the practices of domination, exploitation and administration of alien lands and peoples (Young, 2001). Our focus here will be on the 'formal' European empires which emerged in the early modern period and persisted until the mid-twentieth century, albeit with a certain bias towards the British imperial world. However, we will not attend only to histories of state-backed colonial practitioners; imperialism and colonialism were also practiced through a variety of economic, religious and humanitarian means (Lambert and Lester, 2004), and emerging historical scholarship is showing how

ideas about weather and climate informed the thought and activities of actors engaged in these multiple instantiations of imperialism.

IDEAS OF CLIMATE, IDEAS OF EMPIRE

Climate is ‘as much a philosophical concept as a material entity’ (Endfield & Randalls, 2014: 36). Throughout the nineteenth and early twentieth centuries, climate represented an ‘exploitable hermeneutic resource’ (Livingstone, 2000: 93) used by writers and colonists to frame colonial experience and to give meaning to cultural and environmental distinctiveness [Howell 2015]. ‘Climate’ has, at various times, featured both as an index of weather, stabilising its vicissitudes into a sense of spatial and temporal coherence, and as an agent, exercising decisive influence on the forms of life which live under its meteorological regime (Fleming and Jankovic, 2011). Climatic determinism has loomed large in the intellectual history of the western world, affording climate agency in the shaping of human health, race, productivity, culture, politics and conflict (Arnold, 1996; Livingstone, 2002; Hulme, 2011). Classical theories of climate dating back to Hippocrates have been reworked to explain the distinctive racial, pathological, economic and moral characteristics between different parts of the world. In a European imperial context, climatically-determined differences between human ‘races’ and cultures were central to Western European self-conceptions of an inherent superiority over peoples, offering to early expansionists apparently scientific grounds for believing in their own imperial sense of cultural supremacy. Ideas of empire were intimately bound with ideas of climate – a relationship perhaps best epitomised by Montesquieu’s observation that the ‘empire of the climate is the first, the most powerful of all empires’ (Montesquieu, cited in Livingstone, 2012: 91).

Early European encounters with the tropics, from the fifteenth century onwards, raised new questions about the origins and global migrations of plants, animals and people. In the writings of the Christopher Columbus and his associates, ‘[c]limatic explanations were easily seized upon to explain cultural behaviour and differentiation’ (Grove, 1995: 154). Climatic explanations of human difference were shaped by two key ideas, collectively referred to as the tropical paradox – that of tropical abundance,

and that of differential mortality. The idea of tropical abundance held that tropical areas, with their hot, humid climates and rich soils, were highly biologically productive, and that little human work was required to grow subsistence crops. Travellers like Sir Walter Raleigh sent home reports of tropical inhabitants eating only that which 'nature' brings forth, and luxuriating amid the redundancy of hard agricultural labour. These ideas, solidified in the sixteenth century, had lasting effects on imperial policies and practices, perhaps most notably in taxation schemes which were designed to compensate for the oversupply of cheap, productive land which was thought to keep local wages too high (Curtin, 1990). Such abundant lands were nonetheless attractive places to take control of and exploit. More deeply, Europeans began to wonder whether their inhabitants, apparently free from the consequences of the biblical Original Sin, could even be considered as part of the same human family. Theories of polygenesis began to ascribe different origins to the diversity of apparent racial groups, while the supposed relationship between climate and the necessity of labour contributed to new ideas about the inherent physical and cultural superiority of Europeans. The more testing, fickle climate and relative resource scarcity of Europe had, it was theorised, shaped a more hardy, energetic people, capable of sophisticated social and technological innovations in their struggle with their environment.

The Tropics, in contrast, were constructed as places of moral degeneration, places that fostered indolence and laziness, echoing earlier hypotheses postulated as part of the *Querrelle d'Amerique*, the historical dispute between European and American intellectuals over the apparent antiquity of the Americas, the size and strength of its animal and plant populations relative to those of the Old World, and the moral, intellectual and physical capacity of its populations (Gerbi, 1973). Intertwined climatic, racial and moral ideologies provided an enduring moral and ethno-climatological frame of reference that influenced colonial attitudes, images, tropes and metaphors and afforded travel writers and commentators a 'unique framework within which to explore national and imperial identity' (Taylor-Brown, 2016: 306; on analogous Japanese colonial attitudes to tropical climates, see Zaiki & Tsukahara, 2007). Ideas about the nature of different climates also powerfully shaped the emerging geographies of European imperialism. Geographer William B. Meyer argues that early British colonists of North America saw in the southern Atlantic seaboard a region inevitably akin to the Mediterranean, and which could therefore correct

Britain's trade imbalances in popular products like wine, olives and rice, while also perhaps sating a rapacious mercantile appetite for precious metals which were believed more abundant under a warm sun (Meyer, 2000; White, 2015). The South, therefore, attracted a moneyed, aristocratic, conservative Anglican elite keen on exploiting these new agricultural potentials, in strong contrast to the religious non-conformists who settled the north east. It was this social response to an assumed southern climate which, Meyer argues, led to some of the distinct cultural traits of the southern US, as opposed to the climate itself, to which the culture and politics of the regions have often been attributed (Meyer 2000).

The radical differences of the tropical environments which Europeans explored and colonised – and the apparent differences of the people who inhabited them – were also encountered through the lens of differential mortality. Before the emergence and acceptance of germ theory and the new science of immunology, the very different reactions of different groups to tropical environments reinforced ideas of inherent racial differences. European travellers and settlers struggled against diseases to which the local population appeared to have an inherent immunity, while the converse destruction of many local populations upon European arrival, though occasionally attributed to the cruelty and savagery of the invaders, by the seventeenth century was seen as a divine act, clearing the way for European colonisation of tropical lands (Curtin 1990). We look more closely at the entanglements of racial and medical climatology below, tracing their lineages through later periods of colonisation. In the next section, however, we turn to what historians of science have learned about how this concern for colonial climates shaped emerging infrastructures for climatic knowledge-making.

COLONIAL CLIMATOLOGY AND METEOROLOGY

The spread of European meteorological techniques to colonial settings largely followed two tracks. One track saw early explorers, soldiers, medics, missionaries and, later, administrators, taking with them thermometers, barometers and other bits of meteorological kit, as the recording of weather was positioned as part of the practice of making strange new environments legible to European sciences and states. Another track, gaining momentum rather later, saw more organised and institutionalised efforts to coordinate meteorological observation across global space. Historians have recently started to reconstruct

these processes, with White (2015) for example showing how early European settlers in North America made a number of intellectual breakthroughs which laid the foundations for the later emergence of climatology. Such histories are beginning to show how, like other colonial sciences, the sciences of climate were not simply ‘tools’ of empire: along with related sciences of race and health, they did not just serve to help enact ‘a project already imagined’, but helped bring ‘into being the colonial project itself’ (Seth, 2009: 375; see for example Greer, 2015; Baker, forthcoming).

Globe-trotting mercantile and naval ships had long brought back to European metropolises observations of oceanic weather which started to be pieced together into new pictures of climatic patterns, not least of course the trade winds, which fundamentally shaped patterns of trade and exploration (Naylor, 2015; Schwartz, 2015; Bankoff 2017; also Foxhall, 2010). In India and neighbouring seas, early efforts to understand weather and climate were born of the demands of oceanic trade, of dealing with storms on land and at sea, and in India particularly, of reconciling imperial government with a monsoonal climate. For Grove, the year 1791 represents ‘the first occasion on which weather and agrarian observations made by scientific observers and others in the tropics were sufficiently elaborate and sufficiently coordinated...for some of the first speculations to be firmly made about global rather than regional climatic events’ (Grove, 1998: 302). This was a product largely of the expanding reach of the East India Company (EIC), with new observations possible in colonies and trading posts across the globe, and by a number of EIC staffers who, inspired by the writings of Joseph Priestley and others, took with them a commitment to air and climate as vital elements of health, wellbeing and prosperity. By the 1810s, knowledge was circulating about simultaneous droughts in India, the Caribbean and the embryonic colonies of Australia (O’Brien, 2014a), with figures such as EIC Governor of St Helena Alexander Beatson, formerly a military surveyor in India, becoming key nodes in new networks of meteorological knowledge production.

But this was all still subject to the interest and whims of enthusiastic individuals. The push for more coordinated observational efforts came later, as metropolitan savants expressed new enthusiasm for Baconian modes of thought and the collection of global climatic data in order to draw new inferences about the physical laws governing atmospheric processes. In 1836 Alexander von Humboldt urged the

Royal Society to make better use of Britain's imperial reach in recording worldwide weather patterns (Brock, 1993). Historical attention has recently focused on the subsequent 'magnetic crusade' of the 1840s, which saw the British establishing magnetic, meteorological and tidal observatories at various key points around the empire, including Singapore, Bombay, the Cape of Good Hope, and Toronto. Sustained scholarly interest in this period has revealed how the cooperation of a variety of scientific, military and commercial bodies was central to the imperial expansion of the 'observatory sciences', and how a multitude of interests – few of them purely 'scientific' – fed into the growth of imperial scientific endeavour (Cawood, 1979; Miller, 1986; Hall, 1990; Hunt, 1997; Locher, 2007; Marsden and Smith, 2007; Carter, 2009; Aubin, Bigg and Sibum, 2010; Williamson, 2015).

Few of the observatories established during the Magnetic Crusade continued to function for long or continuous periods afterwards (Williamson 2015) and until the early 20th century, when the rise of international aviation saw meteorology become a crucial 'infrastructural science' (Turner, 2010), only a limited number of European colonies had well-supported 'weather services' (Mahony, 2016; for a brief but valuable discussion of the French colonies, see Duverg , 1995). During the 19th century meteorological effort largely continued to follow shipping – Mauritius, for example, had a dedicated meteorological society from 1851 which compiled ship observations and, largely through the work of Charles Meldrum, ventured new hypotheses about the behaviour of tropical cyclones (Island of Mauritius Meteorological Service, 1974). Such works of compilation continue to reward researchers, this time those endeavouring to reconstruct historical patterns of atmospheric circulation (Allan et al. 2016).

In the Australian colonies meteorology was among the first sciences to be institutionalised, its practitioners serving 'as important environmental interpreters for colonists and governments' (O'Gorman, 2014: 180]. Antipodean meteorology is well recorded by historians, with institutional histories increasingly giving way to more nuanced accounts of the complex motivations behind meteorological knowledge production (O'Gorman, Beattie and Henry, 2016). By the 1860s all the Australian colonial governments had some form of institutionalized meteorology, and the rise of telegraphy meant that regional climates 'took on abstract forms through isobar maps and statistical evaluations'. In so doing, meteorologists 'answered the calls of colonialism and modern science to know

and categorize, and in so doing, control environments' (O'Gorman 2014, 181). Further north, Zaiki and Tsukahara (2007) have shown how Japan's late nineteenth-century imperial expansion, conducted under a rubric of 'scientific colonialism', was accompanied by a rapid expansion of meteorological observatories and an institutionalisation of the science in imperial universities.

In New Zealand, formal meteorological observations began appearing in newspapers in the 1850s, displacing an earlier engagement with Maori weather knowledges and methods of foretelling, although evidence suggests that some of these methods – such as close observation of cloud formations – were picked up by settlers and continued to be used (Holland and Williams, 2014). Future research could profitably focus on these exchanges and hybridisations of knowledge within colonial 'contact zones' (Pratt, 1991; Roberts, 2009). The evidentiary legacies of such knowledges, whether in the form of diaries, correspondence or oral histories, are already being used to reconstruct regional and local climate change (Culver, 2014). The different ways in which people have been affected by and have coped with past climate variability is often embedded into local knowledge systems, passed down through generations in the form of memory, folklore and cultural wisdom (Challinor *et al.*, 2007). These knowledge systems afford important insights into climate-society interactions in the past, with important for lessons for present-day debates about adaptation, vulnerability, and resilience (e.g. Endfield & Nash, 2002; Hannaford, Jones, & Bigg, 2015; Kelso & Vogel, 2015; Nash & Endfield, 2008; Nash & Grab, 2010).

Where reliable meteorological observations in the 19th century did exist, speculation about climatic cycles soon followed. Controversy reigned in Britain and India as to whether the periodic famines striking the latter could be understood through new methods of statistically analysing sunspot cycles (Anderson, 2005; Porter, 1986: 274-78). But the search for cycles was not just about anticipating fickle colonial climates. It was also an effort to make sense of an emerging global economy, shaped by the contours of European imperialism, and to understand how the new 'national' economies of places like Australia and India fitted into the warp and weft of new global patterns of trade and profit. As Mirowski (1984: 346) argues, William Stanley Jevons' work on sunspot cycles, often derided as an intellectual aberration, should instead be considered as part of a unified intellectual project to 'portray the market as a "natural" process, so that doubts about its efficacy would be assuaged, or at the very least, countered by

scientific discourse'. New understandings of a global climate system were being co-produced with new understandings of a global economy.

Katharine Anderson (2005) shows how for British meteorologists in 19th century India, the vast expanse of British-controlled territory offered the prospects of the kind of synoptic insights starting to be developed in continental North America, as well as a proving ground for a new relationship between (meteorological) science and the state as 'mutually reinforcing models of rational order' – a relationship at that time deeply troubled in Great Britain (Burton, 1986; Walker, 2012). In India, the practice of meteorology was seen as a hallmark of 'civilised government', and was suggestive of the kinds of administrative centralisation then being sought in other areas of the British administration: 'The atmosphere, like empire, required discipline on a monumental scale' (Anderson, 2005: 284). Meteorological observation techniques had spread across India, often following 19th century agricultural modernisation schemes (Hazareesingh, 2012). By the late 19th century the meteorological discipline described by Anderson – standardised observations, racial hierarchies of observers, globally circulating datasets – had been starting to yield promising results in the identification of large-scale atmospheric 'teleconnections' (to use a later term) with relevance to the periodic failures of the Indian monsoon, with cooperation between meteorologists in India and Australia at the heart of new networks of data exchange and comparison (O'Brien, 2014a). But while 18th and early 19th century surgeon-naturalists like William Roxburgh were freely critical of the imperial power's response to famine and climatic stress (Grove, 1998), the late 19th century effort to more precisely describe the atmospheric dynamics of monsoon failure and drought served, for Mike Davis, to help naturalize famine. If famine could be 'scientifically' attributed to natural physical causes – as opposed to questions of political economy – the empire would be relieved of direct responsibility for India's devastating famines, while also being emboldened in its efforts to understand, predict and manage tropical environments (Davis, 2001).

Meteorology was, however, far from the preserve of imperial states. Insurance companies played a key role in producing and disseminating claims about the nature and salubrity of distant climates (Kneale and Randalls, 2014). Church missionaries, akin to other 'non-scientific laymen who... travelled abroad', were often derided by contemporaries as being 'trained in dogmatics rather than in the methods

of scientific investigation' (Baker, 1924: 373-374; Harries, 2007). The missionary frontier, however, often ran 'ahead of empire' (Barker 2005, 86), and it follows that representatives of various missionary societies functioned as both explorers as well as evangelists. They provided some of the earliest reports on distant environments and peoples, while their 'long term residential topophilia' provided them with a unique, first hand insight into the 'physical and cultural geography of the landscapes that they inhabited' (Livingstone, 2005: 51). Missionaries, particularly Jesuits, were prominent proponents of meteorological science across the globe and their written legacies have begun to be used for material climatic reconstruction as well as for investigating prevailing climate theories and knowledge systems. (Daston, 2008; Endfield & Nash, 2005, 2007; Harries, 2007; Lüdecke, 2005; Udías, 1996; White, 2015)

As Gregeory Cushman (2013) has shown, Jesuits in particular made major contributions to the understanding of phenomena like tropical storms (also Udías, 1996). They were active hurricane forecasters in the Philippines and Cuba, where clashes of predictive authority with rival Spanish and American empires were frequent. However, Pietruska (2016) has recently demonstrated how in the Caribbean at the dawn of the twentieth century, American meteorological hegemony was re-asserted, largely under the guise of military security interests, but with practices quickly turning to agricultural intelligence and to the securing of profits for American investors. In the early twentieth century, as understandings of global atmospheric patterns grew with the spread of telegraphic networks on the ground and under the sea, the rise of aviation saw renewed efforts to comprehend the atmosphere as a three-dimensional space which could be safely traversed by aeroplanes and airships. While the US perhaps led the way in the establishment of aeronautical meteorology as a behind-the-scenes 'infrastructural science' (Turner, 2010), British hopes that its empire could be tied together by a new network of airships and aeroplanes saw the establishment of new colonial meteorological services in places like British Malaya and British East Africa, often on a federal basis, as emphasis shifted from understanding regional agricultural climates to the provision of synoptic forecasts over wide areas (Mahony, 2016). In South America, neo-colonial competition between American and German aviators created different patterns of meteorological expansion. The maritime meteorologists of the Deutsche Seewarte helped cement German dominance of South American aviation in the early interwar period, but

this was soon subverted by the rise of Pan-American Airways and associated networks of private meteorological services (Cushman, 2005, 2006). The South Pacific represented another interwar ‘contact zone’ between different national meteorological networks, with New Zealand’s weathermen appealing to the imperial metropole for help in establishing a comprehensive ‘all British’ meteorological infrastructure in the Pacific. Expanded meteorological networks could open the airways to national conquest, while also guaranteeing expanded infrastructures of observation and communication which could be vital in times of war (Henry, 2014, 2017).

This upscaling of interwar climatology and meteorology was not, however, universal. The collapse of the Austro-Hungarian Empire following World War I saw the spatial horizons of Austrian meteorologists and climatologists shrink accordingly. While Austrian imperial climatology had accorded with a broader imperial epistemology of seeking unity in diversity (Coen, 2016), climatology in the Austrian republic focused on new, smaller-scale targets – the microclimates of mountain resorts and the ‘artificial climates’ of cities and spaces of work (Coen, 2006). The Austrian case provides further evidence for how the evolution of meteorology and climatology in different places was shaped by local and trans-local structures of political power, the spatial coordinates of atmospheric knowledge-making shaped by the spatialities of rule (Coen, 2011). The multi-national history of polar meteorology and climatology likewise illuminates this dynamic of co-production between science and sovereignty (Howkins, 2008, 2011; Turchetti *et al.*, 2008; Doel *et al.*, 2014; Lajus and Sörlin, 2014)

THE COLONY AS LABORATORY

European colonies were spaces where new forms of political, social, economic and environmental order could be tried out, ‘living laboratories’ where expectation, experimentation and experience collided in efforts to remake the world (Tilley, 2011). In this section, we review work which has examined how imported understandings of climate clashed with lived experience, how assumed relationships between climate, health and place were transformed by the colonial enterprise, and how experiments in agriculture and forestry spawned new knowledges of climate.

Imported understandings

Despite the significance of formal meteorological knowledge-making, colonial life was often shaped more fundamentally by more vernacular knowledges of climate. The imagined geographies of imperial spaces and their climates were frequently at odds with reality and lived experience (Livingstone, 1999, 2000; White, 2015). Recent work by Australasian environmental historians, for example, had shed new light on how expectations of colonial climates often differed radically – and consequentially – from reality (Beattie 2011; Beattie, O’Gorman, and Henry 2014; Fenby 2015). In New Zealand, the country’s potential to be a ‘neo-Europe’, based on a similar climate, rubbed up against the slow realisation of very different meteorological particularities (Beattie 2003, 2014; Holland, Wood, and Dixon 2009; Holland and Williams 2014). Early settlement boosters in New South Wales promoted a climate and soils which would be familiar to the British, and which were ready for easy taming by both farmers and convicts. But expectations of a British-style climate led to serious misconceptions and maladaptation to extremes. A dry period from 1790–3 motivated settlement along the Hawkesbury River valley, which then suffered repeated flood devastation when rains returned, while British definitions of drought, such as a month without rain, did not sit easily with the new climate, wherein drought would later come to be defined as a sustained period of low rainfall impacting upon environment and society (Meinig, 1962; Gergis, Garden and Fenby, 2010). ‘Persistently comparing Australian climate with the familiar climate of England hampered colonists’ ability to understand weather in the new continent’ (Fenby, Garden and Gergis, 2014). In the meantime, settlers to Australia’s northern coast brought with them conceptions of a ‘clockwork’ climate, switching between two seasons with a predictable regularity that greatly contradicted local aboriginal concepts of seasonality, and, in retrospect, climatological data (O’Brien, 2014b). Similar processes of hopes and expectations dashed by colonial experience were at work in Western Australia. Ruth Morgan, through her study of narrative accounts of the 1914 drought in Western Australia, reveals the persistence of a ‘pioneer mythology’ of resilience and adaptation that overlooked other more poignant stories of loss and deprivation linked to drought (Morgan, 2014, 2017). Like in the US (Meyer 2000), the hardships of coming to terms with a new climate shaped emerging senses of national identity, contributing for example to ‘a growing nationalist literary and artistic tradition

that portrayed pioneering hardship as fundamental to the development of a sense of national character' (Garden, 2014: 72; also Berland, 1993).

Climate, health and place

Geographical discussions of climate matters in the nineteenth and early twentieth centuries were linked to issues of empire, ethnicity and also health (Livingstone, 1999; Edmond, 2005; Jankovic, 2006). Moral discourses linking ethnic constitution to regional climatic characteristics (Curtin, 1964; Kennedy, 1990; Naraindas, 1996; Driver and Yeoh, 2000; Livingstone, 2000; Driver, 2004) were interwoven with theories of European acclimatisation or the ability of European civilisation to adapt to 'alien' environments (Livingstone, 1987; Osborne, 2000; Howell, 2015). Certain aspects of the climate were thought to have a particularly deleterious effect on the health of Europeans. The heat, sun and supposed humidity then associated with the tropics was cited as a major reason for 'southern sickness' (Kupperman, 1984: 213). Fears abounded that prolonged residences in such environments would result not only in physical deterioration, particularly among women and children (Bell, 1993), but would also cultivate a 'low sense of morality' (Livingstone, 2002: 168).

Anticipative pathological geographies of the first half of the nineteenth century positioned many parts of European empires as being among the most inauspicious for human development and among the most hazardous for European constitutions (Naraindas, 1996; Wheeler, 1999; Kneale and Randalls, 2014). But the colonies also represented testing grounds for debates about acclimatization, health and wellbeing (Osborne 2000). For much of the nineteenth century, for example, the link between climate and disease was 'absolute', and so it was essential that the climates of new realms were understood first and foremost (Kupperman 1984, 238). Facts were collected about the state of health of individuals and after a time, and no doubt reflecting concerns over the rapidity with which their employees were invalidated, inferences between health and factors such as weather, work, diet and exposure were drawn (Endfield, 2011).

Savage (2004) has highlighted, however, how engagement with other parts of the world resulted in the identification of favourable and unfavourable, healthy and unhealthy locations, comprehended on the basis of similarities or differences to the temperate world. Imperial discourses effectively 'normalized'

the environmental characteristics of other places against the measured standard of the temperate zone. Perceived variations in salubrity were recognised with different latitudes and topography. Some countries such as West Africa or New Guinea were identified as ‘the white man’s grave’ (Mathe-Shires, 2001; Eves, 2005), and tropical plains generally became associated with disease and pestilence. Central, eastern and southern Africa were considered more favourable. Cooler, more temperate mountain regions were also considered to be more favourable for European constitutions, a recognised differentiation that contributed to the development of a perceived spatially-varied pathological geography or ‘medical topography’ (Harrison, 1996). Medical officer and topographer J Grierson for example, writing in the *Transactions of the Medical and Physical Society of Calcutta*, in relation to health problems which had disabled his regiment, identified variable levels of salubrity across South Asia accounting for patterns of ill health among his troops, both indigenous and British (Jepson, 2004).

This de-homogenisation of empire in pathological terms brought opportunity as well as threat. Some colonies or topographic features within colonies began to be identified as places offering ‘climate therapy’ for those invalided back home through old world disease or indeed those whose health had been diminished elsewhere in the colonies. Much has been written, for example, on the development of hill stations in India, the Caribbean highlands and various parts of Africa (e.g. Adamson, 2012; Carey, 2011; Kenny, 1995; Njoh, 2008), and mountainous regions in the tropics generally were recognised as key sanatoria for some of the world’s most problematic diseases (Carey, 2014). By the second half of the nineteenth century temporary stays in some colonial destinations such as Australia, New Zealand and the Cape Colony also offered a retreat from degenerative diseases such as tuberculosis, then associated with crowded urban environments in Europe (Bell, 1993). In her study of domestic healthcare in colonial New Zealand, Joanna Bishop notes how that particular British colony ‘appeared to be the antithesis to the diseases ravaging the British Isles’ and was ‘promoted as an inherently healthy land’ whose climate was considered to be beneficial to the British constitution (Bishop, 2014: 5). Recent work in the Americas has highlighted how the city of Jauja in Peru served a similar function, and ‘was one of the most acclaimed places to cure the disease through climate therapy’. As Carey (2014: 798) shows, ‘various constructions of climate were appropriated and used by various groups- not only physicians promoting the health benefits of high elevation Andean climate - but also politicians, entrepreneurs, the Lima elite and economic

developers seeking scientific justification for their endeavours in the Andes'. Recent research, however, has also highlighted the importance of health in motivating European emigration from colony to colony, for example from the unhealthy tropical plains of India to Australia, New Zealand and South Africa (Beattie, 2012). Hill stations across Australia and New Zealand in particular became places where the public health of British administrators and military personnel could be restored through seasonal furlough and, as Beattie (2012:105) notes, 'officials in Australia's fledgling colonies, along with those in New Zealand and South Africa, clamoured to attract wealthy white settlers from India', commonly sounding 'a note of alarm by playing on the dangers of India's climate while reassuring migrants of their own colony's salubrity'.

Cartographers, surveyors and medical topographers all played a key role in constructing understanding about imperial spaces, identifying localities for optimising acclimatization and selecting landscapes which could offer opportunities for European adaptation to climates and tropical environments in colonial possessions (Jepson, 2004: 140). This offered an important 'counterpoint to the metropolitan scientific community in London' (Jepson, 2004: 145) through local field observation and experience. Indeed, as Johnston (2013: 443) has recently indicated, the more nuanced appreciation of the pathological geography of place in the colonies helped influence the locations and layouts of towns, cities and residences.

As the extent of imperial investment overseas expanded through the second half of nineteenth century, so did the body of medical texts, guides and manuals offering advice for the colonist, be they soldiers, emigrants, labourers or officials, on what to eat, what to wear, and where and how to live. Ryan Johnson highlights how 'everyone from scientists and physicians to missionaries and administrators was bombarded with relentless advertising and abundant advice about the outfit needed to preserve health in a tropical climate.' Studying this 'advice' affords insight into the changing understandings of, and attitudes towards, the health implications of living and working in the colonies, and highlights how commodity cultures reinforced imperial stereotyping. The so-called Tabloid medicine chests were regarded as 'must have' pieces of travelling equipment, while manufacturers' propaganda for these items served to reinforce images of the tropical colonies as pestilential, highlighting disease to be the 'worst menace' in the tropics. The Tabloid chest, however, was marketed as not only rendering travellers 'safe', but also – like the hill

stations – to mark them out as being ‘superior in Britain’s tropical possessions’ (Johnson, 2008: 71-72). In fact, with a progressive shift from monogenic to polygenic thinking, it became important to use European material culture to mark out and identify the distinction between coloniser and colonised, ‘legitimizing the rule of a few over many’ (Johnson, 2008: 73). Recent work by Howell et al. (2013) has focused on the hitherto little studied role of British nurses working in colonial locations and the way in which ‘the tools’ of personal as well as public ‘hygiene’ were used to create ‘physical and cultural boundaries around her white patients and herself, setting colonists apart from their colonial setting’ (p. 338).

Creating distinction and superiority in the colonies became more important throughout the second half of the nineteenth century and was manifest not only in clothing and medicine, but also lifestyles and the built environment which the colonists created. Chang and King (2011) identify a genealogy in the development of distinctive tropical architecture which is inextricably linked to shifting climatic, racial and medical discourses. Three ‘moments’ are identified. In pre-nineteenth century India, for example, tropicalized stereotypes focused on ‘adaptation and transculturation’, whereby indigenous concepts and initiatives, such as the bungalow, and interior mechanisms for ‘climate control’ such as verandahs and punkhas were adapted by European colonists. By the early nineteenth century, with an erosion of the ‘previous reverence for indigenous knowledge’, there was a shift towards a metropolitan-designed tropical architecture that sought to protect Europeans from miasmatic threats, symbolically also addressing the ‘widespread anxieties about the degeneration of white bodies in the Tropics’ by establishing ‘a visible assurance of the colonists’ cultural identity’ and a separation and distance from indigenous practices and ways of life. This phase coincides with ‘bodily interventions’ linked to colonial clothing. Planning policies likewise found expression as instruments of power, domination and social control in urban space in colonial Africa (Njoh, 2008). By the early twentieth century, however, new developments saw sanitary and housing improvements which were not restricted to European colonists but their employees too, albeit ‘not out of benevolence but because of economic calculations’ - the workers being central to tropical economic production. Designs themselves were still heavily influenced by long standing climatic medical theories, despite the advent of germ theory around the turn of the twentieth century (Chang and King, 2011: 295). Indeed, while these discourses are very mobile from the eighteenth through to the twentieth century, they do all privilege climate as a key influence.

Climate, agriculture and forestry

Colonial expansion was intimately linked to the transfer and acclimatisation of plants (Osborne, 2000; Crosby, 2015; Ross, 2017) and these transfers were always accompanied by circulating ideas, knowledge and scientific techniques (Beattie, Mellilo, & O’Gorman, 2015; Flikke, 2016). Towards the end of the 18th century, for example, important innovations took place in colonial agriculture and a new network of botanical gardens emerged which played a central role in the ecological and agricultural transformations of the European empires. Botanical gardens had emerged in early modern Europe to support both an expanding medical profession and theological missions of recreating the lost Garden of Eden (Prest, 1988). Imperial botanic gardens, however, were pivotal to the plant exchanges and scientific developments that resulted in the introduction of new plantation crops in the colonies (Brockway, 1979: 450; Drayton, 2000). The establishment of the Calcutta Botanic Garden in 1787 was motivated in large part by the wish to gather together drought-resistant types of popular crops, and to then distribute them to regions threatened by famine (Grove 1995). The Botanic Garden was a means of building resilience to a capricious climate, and thus of shoring up the legitimacy of the colonial state. Nonetheless, key figures in the network of imperial and colonial gardens were often the most vociferous critics of the environmental impacts of colonial rule (Grove, 1998; see also Cushman 2011).

Botanic gardens were sites of experimentation in acclimatisation and played a key role in generating and disseminating useful scientific information worldwide on a hitherto unprecedented scale (Osborne 1994). There were similarly ambitious experimental arboreta and plantations across many colonies and the types of trees introduced to colonial landscapes provides additional insight into prevailing climatic and medical understandings. As Bishop notes for New Zealand, for example, nurserymen, botanists, agriculturalists and gardeners introduced medicinal plants and many popular species used regularly by British practitioners, such as dandelion, plantain and dock, naturalised easily and readily in their new environment (2014: 10). Botanists believed ‘eucalypts helped to cure malaria and other tropical diseases by both draining swamps because of their vigorous growth and through the secretion of their scented powerful oils which subscribers to the miasmatic theory of disease believed would kill malaria’ (Bennett, 2011: 269). The olfactory benefits addressed concerns over noxious miasmas while

providing, as Flikke (2016: 25) notes, ‘airborne “paths” which promised physical restoration, health and wellbeing as settlers negotiated the treacherous alien terrain with an eye to the ground and nose to the air’ (see also Ingold, 2010). Not surprisingly, eucalyptus trees were ‘a ubiquitous presence on many southern Indian hill stations,’ but were also introduced to hill stations elsewhere in New Zealand and Australia as a result of their health giving properties (Beattie, 2012: 114). Towards the end of the nineteenth century scientific forestry and forest conservation policies were emerging across the European empires, supported by a range of ideological rationales. In a dominant European colonial imaginary, for example, treeless landscapes were considered a sign of cultural inferiority, despite the fact that around the same time, ‘shrinking forests of Europe were taken as a sign of European technological and cultural superiority’ (Flikke, 2016: 22). The drive to conserve forests among colonial governments was motivated to a large extent by desiccation theory and the belief that forest protection and planting would ‘improve’ local climates (Barton, 2002; Davis, 2004; Grove, 1995), along with the economic imperatives of administrations keen to monopolise and maximise revenues from forested lands (Bennett, 2015; Rajan, 2006). As well as new revenue streams, colonial forestry gave rise to new knowledges of climate. Environmental historian Brett Bennett has argued that nineteenth century foresters in Australia and South Africa saw climate as the key factor in experiments with new trees, often to the ridicule of their European contemporaries. The mantra ‘fit the tree to the climate’ arguably dictated the Cape Colony’s forestry policy at the turn of the century, with figures such as David Ernest Hutchins, C.B. McNaughton and Harold Fulcher Swain developing new techniques of comparative climatology to elucidate, for example, which Australian species might best be grown in different regions of South Africa (Barton & Bennett, 2011; Bennett, 2011). This comparative approach had long been at the core of colonial knowledge-making: ‘According to James Hector, the [New Zealand] government scientist, the principal aim of collating standardised meteorological observations was to facilitate comparison of the New Zealand climate with that of other countries’ (Holland & Williams, 2014, 87). Whereas earlier forms of settlement and agricultural policy in the British Dominions had been motivated in part by ideas of climatic similarity between Britain and her new possessions, by the early twentieth century ideas of climatic equivalence were emerging between colonies and dominions themselves, informed by these comparative climatologies. In 1924 C.C. Robertson of the Research Branch of the Cape Colony’s

Department of Forestry was sent to Australia to investigate the provenance of imported eucalyptus species growing in South Africa and returned with a map that ‘transposed the latitudes of each country onto each other’ intended to help Cape foresters ‘visualise more clearly how the two countries’ climates potentially overlapped’ and thus identify ‘climatically matched’ species (Bennett, 2011: 276).

But efforts to reconcile colonial expansion with climatic conditions were not just about the simple production and application of knowledge. They were often characterised by struggles over scientific and political authority. For example, in mid-19th century South Australia, the ‘rainfall line’ drawn by government surveyor G.W. Goyder became a lightning rod for disagreements over the place of expert knowledge in government policy. Goyder’s line, which marked a zone of decreasing rainfall reliability, was swept up into arguments about demarcations between agricultural and pastoral land uses, amid pressure to expand permanent settlement and farming and in the context of ideas that settled farming would enhance rainfall levels (Douglas, 2014). By the late 1870s ‘the whole concept of any rigid “nature’s” limit was being replaced by the idea that man’s actions could and/or were overcoming nature’s deficiencies’ (Meinig, 1961: 212). But by the early 1880s Goyder had apparently been vindicated. Yields fell, rain never followed the plough, and drought took hold again. As Donald W. Meinig and Kirsty Douglas have both shown, the epistemic struggles over land and climate in South Australia were also struggles over the rights of a colonial government to regulate settler behaviour, over the relative authority of climatological, ecological and agricultural expertise, and over the relative power of official expertise as opposed to ‘folk experimentation’ in new landscapes. Then, as now, debating climate and climate change was also to debate the rights of experts and governments to draw lines and limits around people’s behaviour.

COLONIAL CLIMATE CHANGE

If colonies functioned as a kind of laboratory, then the ability of humans to directly influence the climate was one of the chief objects of observation and experimentation. In colonial America, the vagaries and extremes of climate were often attributed to divine intervention, from God punishing early settlers for their deviations, to Almighty assistance – with fogs or rain storms – in the War of Independence. But a shift from religious to secular interpretations of climatic processes accompanied

America's rejection of British rule. The poet and politician Joel Barlow identified in *The Columbiad* the limiting forces of climate, of flood and frost, with the yoke of British imperial rule, and exclaimed that political independence would also mean freedom for Americans 'to conquer the land and the atmosphere', to put the genius of science to work in taming the climate in which the young nation would emerge triumphant (Meyer 2000, 41; Golinski, 2007). In so doing, Barlow touched upon a number of debates about the potential of climate not just to shape human affairs, but for human actions to shape climate.

As historians Christoph Bonneuil and Jean-Baptiste Fressoz (2015: 176) have recently argued, 'European colonial expansion played a key role in the emergence of reflection on anthropic climate change'. As the European powers expanded in all directions of the compass, new questions were raised about why climates on similar latitudes could be so different, most notably on opposite sides of the Atlantic, and crucially whether humans had any hand in making them so (Kupperman, 1982; Meyer, 2000; Fleming, 2005; Cushman, 2011; White, 2015). Much debate revolved around the links between forests and climate, and the possible impacts of deforestation on climates at local, continental and even global scales. Some understood the seemingly moderate, benign climate of north-western Europe as being a product of centuries of deforestation, and this informed a drive to 'improve' the seemingly more capricious climate of eastern North America through the large-scale felling of forests and the drainage of swamps. Early European settlers struggled to understand the causes of north-eastern North America's harsh and volatile climate according to classical ideas of latitudinal gradation. While a number of boosters sought to play-down the hardships of the New England winters and the sweltering summers of the southern colonies, others reasoned that the European climate had been tempered by millennia of deforestation and cultivation, while the North American continent remained raw and untamed. John Evelyn, a councillor of the Royal Society, argued in his 1664 work *Sylva* that the high humidity levels of North America and Ireland, and their associated negative effects on settler health, could be attributed to the dense forests, which attract rainfall and mists. Cutting these forests would moderate the rainfall and improve the soils and airs – a process which he argued was already underway in New England following just a few decades of settlement (Fleming 2005). These ideas of climatic improvement became central to

the colonial enterprise, resting as it did on claims that Europeans had a right, even a duty, to ‘civilize’ both barbarous peoples and wild nature (Golinski, 2007; Siiskonen, 2015). With John Locke promoting cultivation as the hallmark of the relation between land and property, climatic improvement took a central place in the ideological underpinnings of European expansion (Thompson, 1980).

These arguments were not uncontested. Vogel (2011) reports correspondence in the *Transactions of the Royal Society* which challenged claims of anthropogenic warming in the North American colonies, citing similar temperature trends in Ireland – a colony then ‘lying fallow after the Cromwellian Wars and the difficulties of the Stewart Restoration’ (p116), with processes of land clearance and deforestation going into reverse. Historians of this period have paid only modest attention to the knowledge-making practices which underpinned these claims and counter-claims of climatic change. This is partly a function of available sources – personal observations and testimony jostled for authority in the early modern period, before the rise of coordinated, instrumental meteorology and climatology. Our histories of knowledge practices are therefore largely limited to later periods when questions of scientific method came to the fore in settler engagements with colonial climates. Important questions remain: how certain accounts of foreign or changing climates acquired authority while others didn’t; how personal, bodily experience intersected with proto-scientific forms of observation and recording; and the effects of changing publication practices on the cultural circuits through which climatic claims travelled across continents and oceans.

While debates about forests and anthropogenic climate change pre-date the European settlement of North America, and are traceable to antiquity (Hughes, 1985), the climate-forest issue arguably only became a coherent body of thought in the 18th century. John Woodward’s development of the concept of transpiration in the late 17th century, and its later refinement by Stephen Hales and Count Buffon, undergirded new concerns about the links between forest vegetation and the atmosphere (Grove 1995). While in North America deforestation was seen for a long time as a way of improving the climate, elsewhere forests came to be seen more favourably. As regulators of the exchanges of moisture between land and atmosphere, forests had the effect of usefully drying wet land, and of bringing moisture to otherwise dry regions. In this view, deforestation represented a rupture in the natural and providential

order of things, and climatic protection was cited as one of the major motivations behind early efforts at forest protection in Europeans colonies and territories such as St. Helena, Mauritius, India and New Zealand (Barton 2002; Beattie 2003; Ross 2017). ‘From the 1820s on, a powerful discourse of what could be called “climatic orientalism” warned the European states against deforestation and climate change by recalling the ruins of brilliant civilizations now surrounded by desert’ (Bonneuil & Fressoz, 2015: 179). Forest conservation could preserve rainfall, prevent flooding and soil erosion, and thus ensure the sustainability of civilizational dominance.

In 19th century Australia, newspapers expressed general support for the theory that forests shaped local climates and should thus be conserved. From 1870s, Indian foresters began to arrive in Australasia as they took up jobs in emerging forestry bureaucracies, and they shaped environmental debates in profound ways (Barton 2002; Beattie 2011). But dissenting voices also started to emerge, whether from settlers who subscribed to ‘rain follows the plough’ (Douglas 2014), or from those who advocated, echoing earlier North Americans, deforestation for climatic improvement in more temperate zones like Tasmania. However, the emerging meteorological establishment began to challenge ideas of human influence, leading to epistemological conflicts over the best way to make sense of a changing climate – close meteorological monitoring, of the kind seemingly practiced by the German Meteorological Forestry Service from 1875, or place-based historical knowledge of changing landscapes (Legg, 2014).

In the mid-nineteenth century there was still little support for forest conservation in Britain’s colonies forthcoming from London, but the initiative of the likes of John Croumbie Brown, Colonial Botanist at the Cape Colony, saw local legislation put forward on conservation measures (Siiskonen 2015; Beinart, 2008). In Dhawar in western India, where meteorological observation had expanded during the 1850s alongside experiments with new cotton varieties, concerns about the local climatic effects of rapid deforestation, and about the sensitivity of imported cotton strains to climatic stress, combined to produce new modes of governmental intervention in the environment. Alexander Gibson, Superintendent of the Dapuri Botanic Garden in Poona, drew on the experiences of local farmers to argue that the climate was becoming drier and more hostile. Gibson would go on to become Conservator of Forests for the Bombay Presidency, an institute set up as part of a wider move towards climate protection, but soon found his

conservationist instincts met with an often contrary demand from the colonial government for timber revenue (Hazareesingh, 2012). Nonetheless, ‘climate theories that explained how forest lands affected rainfall, along with soil preservation, water flow, animal life, and the preservation of a variety of forest flora and fauna made forestry the most pressing environmental issue of the late 19th and early 20th centuries’ (Barton, 2002: 9).

Climate control

Climatic variability was a constant cause for concern for both indigenous societies and European colonists. Both groups, however, comprehended and responded to this variability within the frameworks of their own climatic philosophy. The imperial positioning of climate within what Livingstone (1991, 1995, 2002) has referred to as a ‘moral economy’, for example, and particularly the association of drought with wayward indigenous practices, has been discussed elsewhere, and above (Endfield and Nash, 2002a; Davis 2004; 2007). Indigenous societies in many parts of colonial Africa, however, conceptualised and responded to climatic variability within their own ethno-climatic frame of reference. Rainmaking ceremonies were among a number of key drought responses among indigenous communities in central southern Africa (Landau, 1993: 3), even if such practices were considered by early colonial settlers, specifically missionaries, to be indicative of heathen superstition and, as such, a barrier to the civilising mission.

From the colonists’ side, anxieties about extreme climates, and their apparent changeability, combined with imperial confidence in human power over nature to inform a number of fantasies of climatic control. The German architect Herman Sörgel’s scheme for the damming of the Mediterranean and the engineering of African climates is a particularly noteworthy example of a colonial dream of climate control which, although never realised, gained great cultural traction and was re-worked for a variety of political contexts – the Weimar Republic, the Third Reich, and the Cold War. Dubbed *Atlantropa*, the scheme would drain the Mediterranean, sourcing near infinite hydroelectric power from dams at Gibraltar, Port Said and Gallipoli, would check the apparent expansion of the Sahara (Davis, 2016) and, through the construction of gigantic lakes further south, would open up new lands – with moderated climates – to European settlement. This engineering of African climates and environments

was reasoned to be a way of ensuring continued European domination of the continent, while the infinite supply of electricity was expected to bring peace and cultural and economic renewal to a united Europe (Lehmann, 2016). This pairing of environmental anxiety and boundless technological optimism, and political cosmopolitanism with racist imperialism, built upon earlier French ambitions to flood large portions of the Sahara and moderate the climate (Heffernan, 1990; Létolle and Bendjoudi, 1997; Marcot, 2003; Davis, 2007), and echoed others' plans to 're-water' the Kalahari (e.g. Schwarz, 1920; McKittrick, 2015).

When attempts to control colonial climates did emerge in practice, they were usually on a more modest scale. A long drought in Queensland between 1895 and 1903 saw government meteorologist Clement Wragge attempt cloud seeding with artillery guns (Powell, 1991; Garden, 2014), but in late 19th century North Otago, New Zealand, official meteorologists were rather more circumspect about such experiments. Anxieties about a dearth of rainfall led to a curious set of locally-funded rainmaking efforts, which frequently put in conflict popular opinion, religious ideologies of environmental stewardship and a professionalizing meteorological establishment keen to establish its credentials as an authoritative science, distinct from popular prophesy and from folk remedies for drought (Beattie, 2014; also Henry, 2015). While early 20th century meteorologists showed their status anxiety through very public denunciations of climate control schemes, the early Cold War revival of weather modification, particularly rainmaking, saw techniques and theories flow from American scientists like Irving Langmuir (see Fleming, 2010) to places like India and South Africa. Efforts to revive the British government's infamously famished 'groundnut scheme' in Tanganyika by shooting silver iodide bombs at passing clouds (Mahony, in review) nonetheless paled in comparison to contemporary American efforts to divert hurricanes with nuclear weapons – just one indicator perhaps of the shifting loci of western imperial power in the post-war period, and harbingers of the even more ambitious geoengineering ideas which would emerge a few decades later (Fleming, 2010; Harper, 2017).

Conclusion

This review has illustrated how climate theories have been used ideologically, politically and practically in a variety of colonial contexts 'to promote the transformation of nature for human benefits, to qualify

spaces and segregate races, to govern populations, and sometimes denounce environmental transformation' (Locher and Fressoz, 2012: 581). However, recent historical work has also highlighted the malleability of climate theory in colonial contexts over time and space. Furthermore, we have observed how an earlier scholarly interest in the ideological aspects of climatic and imperial thought has recently been supplemented by a new emphasis on the practices of colonial life and rule. Historians and historical geographers have shed new light on practices of climatic knowledge-making in the colonies, taking the history of meteorology and climatology out of the global North and showing how those sciences developed in the cultural and epistemological contact zones of the European empires. New scholarship on climate, health and place is showing how despite the rise of germ theory in the late 19th century, climate theories proved to be pervasive, and concerns about climate continued to inform the practice of colonial medicine and architecture. In the fields of agriculture and forestry, new historical work has shown how colonists sought to work with and adapt to local climates, often through lessons drawn from inter-colonial networks of information exchange.

Much historical interest has recently fallen on colonial ideas about climate change. While we would caution against this work simply being oriented around a quest for antecedents of more recent concerns about global climate change, this scholarship nonetheless shows important historical continuities with the present, not least in struggles over the role of experts and governments in identifying and responding to environmental changes, and in the troublesome links between efforts to regulate environments and to regulate human conduct. Furthermore, this history shows the Janus-faced capacities of scientific knowledge to both naturalise structures of power and domination, and to serve as a vector of resistance. Colonial designs on deliberate climatic improvement likewise provide cautionary tales for today's aspiring geoengineers.

Significant gaps remain in this scholarship though, not least work on contexts outside of the major British Dominions, and indeed outside of the Anglosphere. Little is known about the history of meteorology and climatology in French, German or Portuguese colonies for instance, although such work is starting to emerge (see Mahony and Caglioti, forthcoming). Furthermore, a recent turn in imperial history towards examining the circuits of material, economic and scientific exchange between – as well as within –

empires offers a useful lens for examining the histories of atmospheric science beyond national frames of reference (see Lester 2006, 2015). More work is also required on contacts between settler and indigenous knowledges of climate, and on the processes of exchange by which hybrid forms of expertise and practice emerged at the nexus of diverse cultural groups, scientific communities, and imperial formations. Recent work on the ‘go-betweens’ and cultural translators who shaped imperial practices and encounters points to one way of finessing bipartite and core-periphery models of imperial relationships (Raj, 2016), with promising implications for how we construct histories of climate and colonialism. Nonetheless, scholarship on climate, colonialism and empire is a burgeoning and exciting field which has much to offer not only students of imperial and environmental history, but also students of modern-day climate politics.

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